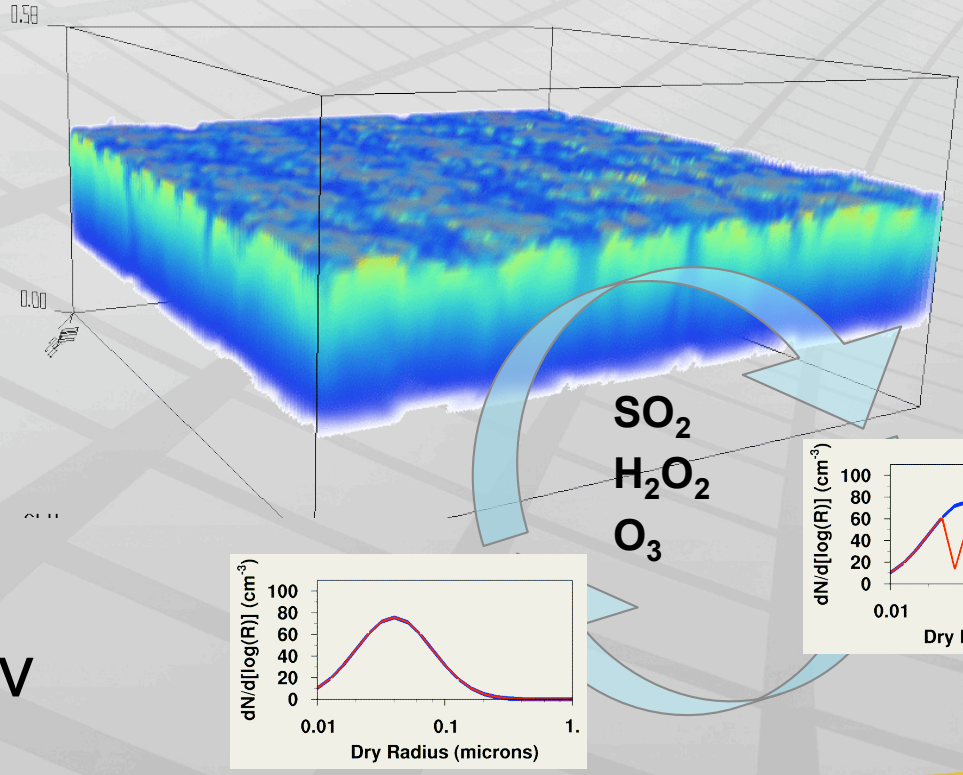
Changes in Aerosol Size Distribution due to Aqueous-Phase Oxidation of SO_2 in Nonprecipitating Stratocumulus Clouds



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Proudly Operated by Battelle *Since 1965*

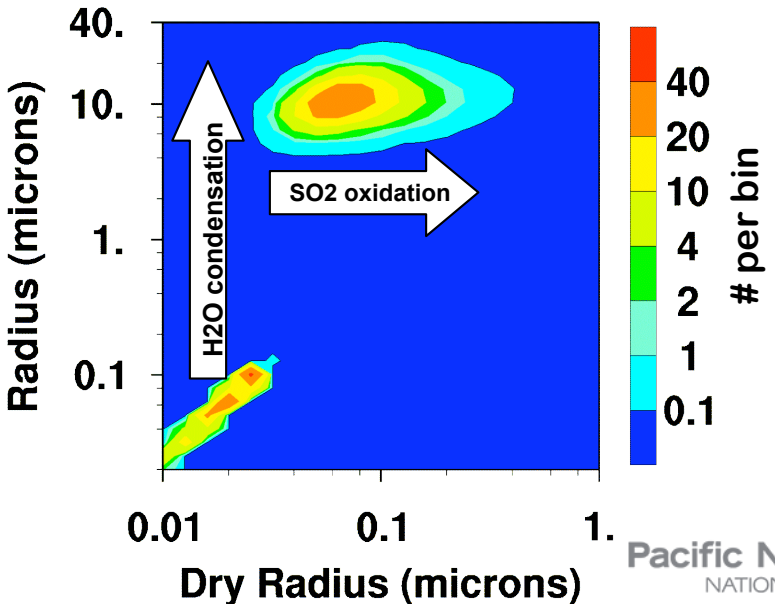
Predicting changes in aerosol spectrum is challenging

- Sulfate production is a strong function of cloud liquid water
- What we really want to know is :

  How aerosol (CCN) spectrum changes, or
  how much each activated particle grows.
- How much water is associated with each activated particle ?
- Most existing tools/models do not provide that information => model development

2D joint aerosol-droplet size distribution

Single-composition aerosol
(ammonium bisulfate)
30 dry size bins **×**
50 wet size bins **≈ 1200** total bins
Water condensation/evaporation
SO_2 oxidation in aqueous phase



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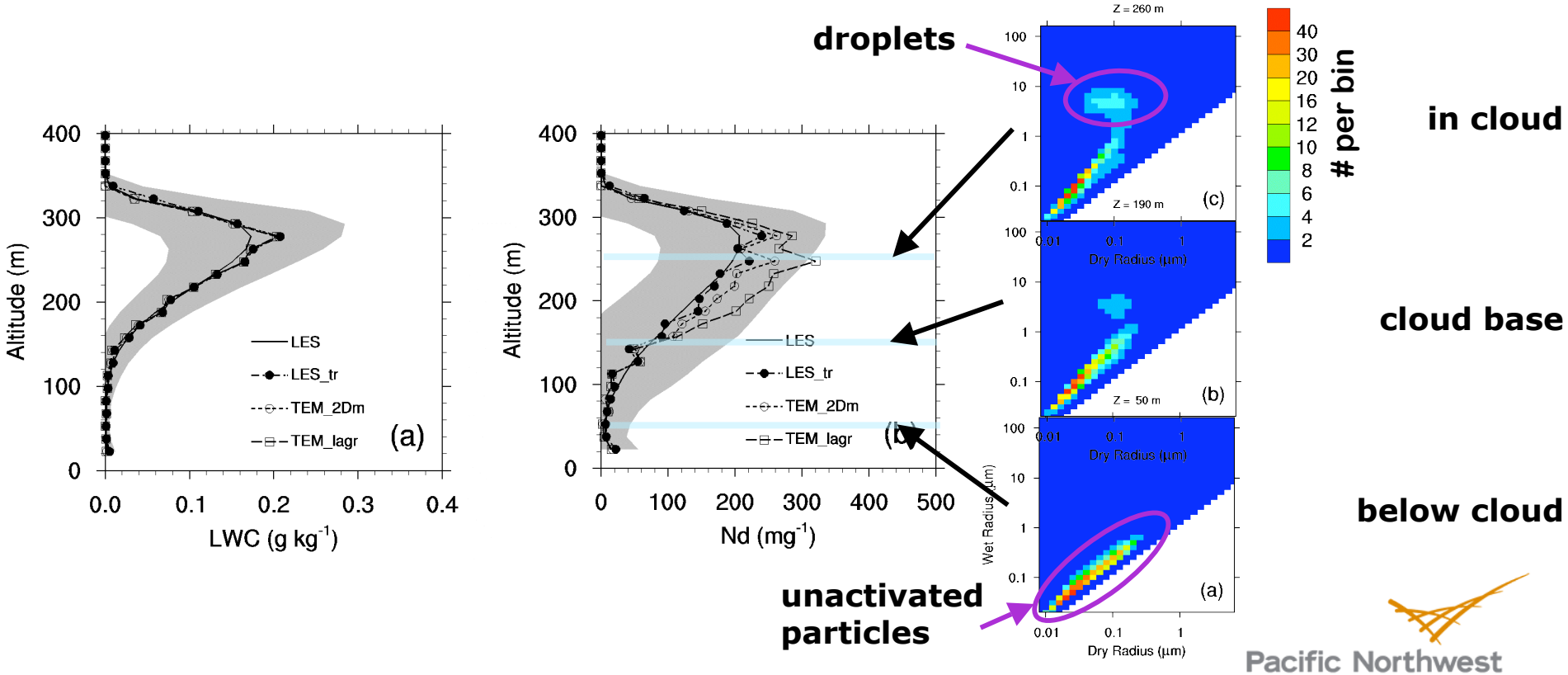
The new model keeps track of aerosol particles inside droplets

MASE 25 June 2005 case:

Shallow coastal Sc; low liquid water content; high aerosol concentrations (~900 cm^{-3}); low pollution levels

Large-eddy simulation and trajectory ensemble model

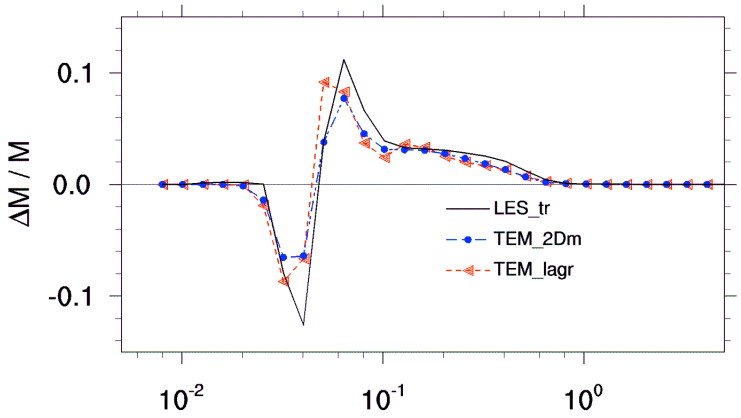


Knowledge expansion = data reduction

One-hour simulation

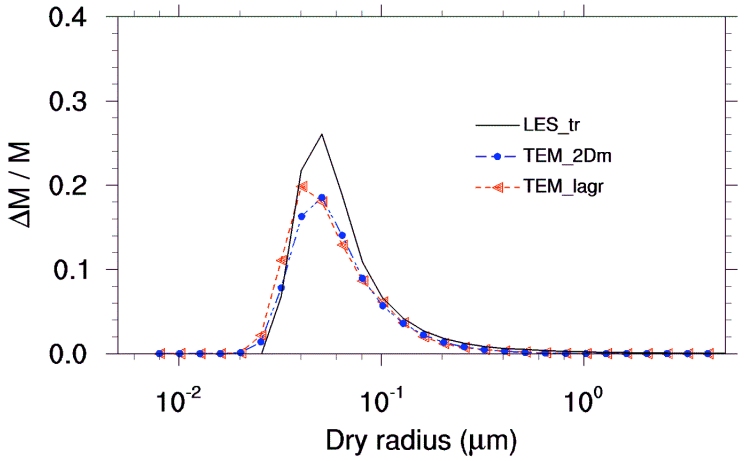
150,000 spatial grid cells ×
1200 variables ×
3600 time steps ≈ 10^{12} pieces of information

Relative mass change per dry-size bin



OR

Relative mass change per particle



Different modeling approaches agree well with each other

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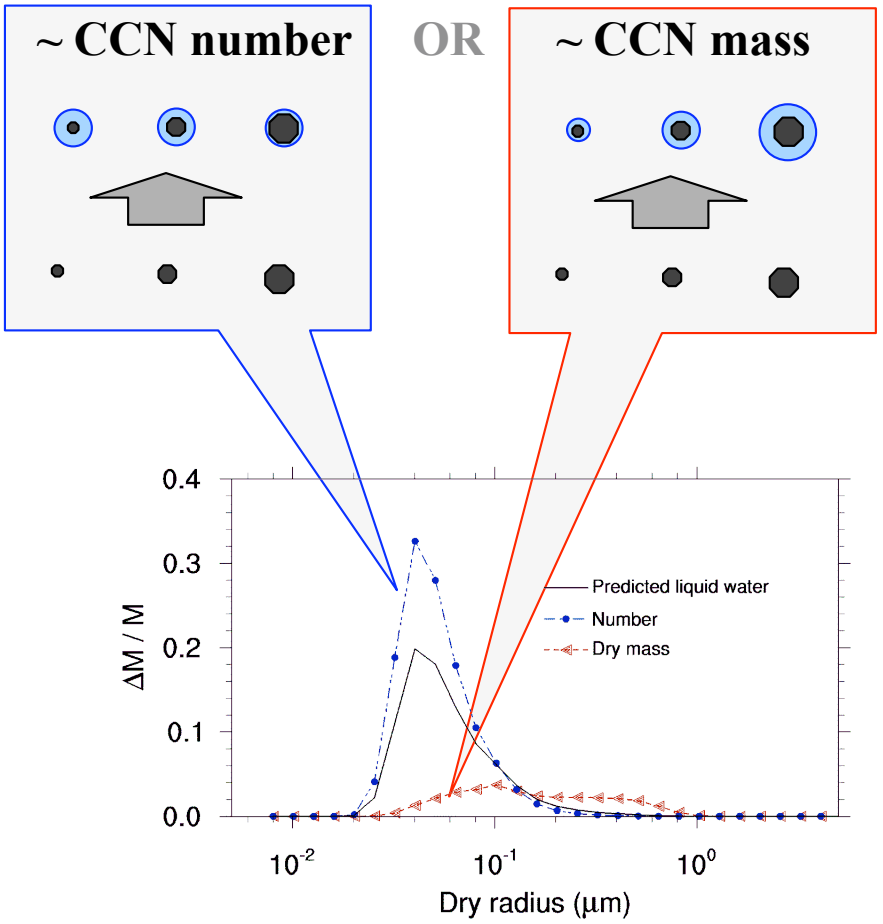
Parameterization evaluation: Do GCM assumptions hold ?

Assumed partitioning of water among activated CCN:

In this case, *a priori* partitioning of liquid water by number (mass) of activated CCN significantly overestimates (underestimates) the aqueous chemistry growth at sizes where relative growth and number-spectrum changes are largest.



Relative mass change per particle

Ovchinnikov and Easter, 2009: Aerosol processing in non-precipitating marine stratocumulus clouds. JGR, submitted.

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